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Before the  
Federal Communications Commission  
Washington DC 20554

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In the Matter of

Reallocation of the 216-220 MHz, 1390-  
1395 MHz, 1427-1429 MHz, 1429-1432  
MHz, 1432-1435 MHz, 1670-1675 MHz,  
and 2385-2390 MHz Government Transfer  
Bands

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WT Docket No. ~~02-108~~

RM-9267

RM-9692

RM-9797

RM-9854

RM-9882

02-81  
FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF THE SECRETARY

Comments of AeroAstro, Inc.

March 4, 2002

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Before the  
**Federal Communications Commission**  
Washington DC 20554

In the Matter of	)	
	)	WT Docket No. 02-08
Reallocation of the 216-220 MHz, 1390-	)	RM-9267
1395 MHz, 1427-1429 MHz, 1429-1432	)	RM-9692
MHz, 1432-1435 MHz, 1670-1675 MHz,	)	RM-9797
and 2385-2390 MHz Government Transfer	)	RM-9854
Bands	)	RM-9882

**Comments of AeroAstro, Inc.**

AeroAstro, Inc. hereby files these Comments in the above-captioned rulemaking.<sup>1</sup>

AeroAstro comments only on the 1670-75 MHz band. AeroAstro takes no position on other bands at issue in this proceeding.

**A. Summary**

AeroAstro seeks to use the 1670-75Hz band for uplinking short data messages to a satellite from small, low-cost mobile ground terminals. These terminals, which are indistinguishable from low-power terrestrial transmitters, will operate at maximum peak power of one watt or less, in full compliance with the Commission's Rules on unlicensed spread spectrum devices (except for choice of band). AeroAstro will not conduct space-to-earth operations in this band.

AeroAstro favors the most flexible rules consistent with preventing interference to other users. We support nationwide licensing, as do all other parties to this proceeding that have specific proposals for the band. Nationwide licensing will maximize the value

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<sup>1</sup> *Reallocation of the 216-220 MHz, 1390-1395 MHz, 1427-1429 MHz, 1429-1432 MHz, 1432-1435 MHz, 1670-1675 MHz, and 2385-2390 MHz Government Transfer Bands*, WT Docket No. 02-08, Notice of Proposed Rule Making, FCC 02-15 (released Feb. 6, 2002) (Notice).

of the spectrum for nationwide offerings. Because of the delays in inherent in rolling out a satellite service, we request either a twenty year licensing term or a renewal standard that requires not "substantial service," but rather "substantial progress toward providing service." Suitable benchmarks might include commencement of construction, completion of construction, and contract for launch.

AeroAstro favors controlling out-of-band emissions with an absolute power spectral density limit. Use of an absolute limit, rather than an emissions mask tied to in-band power, will permit a provider that uses low power to specify a less steep emission mask, and hence a less expensive radio, while still achieving the same degree of adjacent-band protection.

AeroAstro proposes a level of -80dBW/Hz. But we are committed to protecting the radio astronomy and radiosonde operations at 1660.5-1670 MHz. If those users determine our proposal is inadequate, we will work with those users to arrive at mutually acceptable limits.

#### **B. About AeroAstro**

Since its founding in 1988, AeroAstro has focused exclusively on lowering the cost of working in space so as to make space activities accessible to a broader community. The company has brought space to students at high school through post-graduate level, scientists operating on very limited research budgets, small start-up businesses, and the general public. In doing so, AeroAstro has pioneered new uses of space and spacecraft that are appropriate to our low cost, highly accessible approaches to aerospace engineering.

For more information on AeroAstro's track record, see Appendix B.

### **C. About SENS**

AeroAstro's Satellite Enabled Notification System (SENS), now under active development, enables users to transmit short data messages from any location on the globe, for receipt via the Internet in near-real-time. The system has three key components: (1) small, low-cost mobile ground terminals, (2) small, low-cost space stations, and (3) fixed ground receiver stations. The mobile terminals transmit low-power, spread-spectrum modulated messages to the satellites, which act as bent pipes to relay the data down to the nearest ground receiver station.

SENS hopes to use the 1670-1675 MHz band for its mobile terminals. These are direct sequence spread spectrum transmitters, operating at maximum peak power of one watt or less, in full compliance with Section 15.247 (except for choice of band). These are technically and functionally indistinguishable from low-power terrestrial transmitters, even though their signal is received at a satellite. *AeroAstro will not conduct space-to-earth operations in this band.* AeroAstro is currently negotiating with MSS providers about access to ITU-allocated, FCC-licensed downlink service link spectrum, and will seek Commission approvals at the appropriate time.<sup>2</sup>

SENS user terminals have the lowest cost, complexity, size, and weight, and require the least supporting infrastructure, of any space-based communications system to

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<sup>2</sup> SENS can also be operated in a terrestrial mode, for applications over a small area. Instead of a satellite, this implementation uses a tower-mounted receiver with line-of-sight to the active terminals. Interference considerations are identical to those for the satellite system. Similar terminals can be used for both terrestrial and satellite applications, if the same frequency band is available for both.

date. In commercial quantities, the terminals will cost only a few dollars each to manufacture. A global quasi-real-time service will need only two small launches of clusters of very low cost microsatellites. Thus, both the user's terminal and access costs will be very low. Small size and minimal cost will enable SENS to provide critical services not presently available.

**Technical information.** Using direct sequence spread spectrum, very low power, and a very high gain satellite-based receiving antenna, SENS emissions are highly spectrum efficient and non-interfering. Like other spread spectrum applications, SENS signals can share spectrum with narrowband or other spread spectrum signals with little risk of harmful interference. Terminal data message length is restricted to approximately 128 bits. Data rate will be 100 bits/second, for a transmission time per message of about 1.28 seconds. Terminals can be programmed to transmit 2-3 messages in a 24 hour period, as well as to transmit on command from an attached sensor (to report a button press or an alarm condition). Output RF power from a terminal will be approximately -33 dBm/Hz. Low power output makes the terminals safe in any application.

For more details on SENS, See Appendix A.

#### **D. Licensing Plan**

**Flexible use.** The Commission asks whether new terrestrial services in the subject bands should be governed by Part 27 of the Commission's Rules.<sup>3</sup>

AeroAstro supports application of Part 27, with updated technical provisions. This approach will afford licensees maximum flexibility in use of the band, subject to the

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<sup>3</sup> Notice at paras. 16-21, 78-80.

interference considerations discussed below. This approach will encourage use of the band for the services of greatest value to society, and so is in the public interest.<sup>4</sup> Flexible rules will tend to maximize investment, rather than deter it, because they permit licensees to provide whatever services they determine the public needs, and to change those offerings as needs evolve.<sup>5</sup> Arbitrary service rules, on the other hand, amount to substituting the Commission's judgment for that of the marketplace -- a form of "central planning" that tends to impede efficient spectrum use. Flexible rules *per se* need not result in harmful interference among users if the technical rules are appropriately drawn.

***Nationwide licensing; no band managers.*** AeroAstro continues to support nationwide geographic licensing of the 1670-75 MHz band. The Notice observes that all three parties with specific proposals for this band favor nationwide licensing, notwithstanding their very different offerings.<sup>6</sup> AeroAstro has concluded that a national roll-out is necessary to justify the cost of implementing its satellite-based technology. ArrayComm, proposing new specialized wireless services, credibly states that it needs a national footprint in order to overcome the advantages of incumbent wireless providers. MicroTrax notes that, without a national license, its proposed personal location and monitoring system will be restricted to the "artificial fences" of a regional licensing plan.

Other forms of geographic licensing, such as the use of Economic Areas or (worse) Component Economic Areas, make it possible for bidders in a few geographic

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<sup>4</sup> See Notice at para. 19.

<sup>5</sup> See *id.*

<sup>6</sup> Notice at para. 32.

regions to make a nationwide system uneconomical. The effect can be to depress overall auction returns, if would-be nationwide providers such as AeroAstro, ArrayComm, and MicroTrax are forced out of the bidding. To maximize the value of spectrum for nationwide systems, the Commission should adopt nationwide licensing.

Because proponents of the 1670-75 MHz band propose uniform nationwide services, there will be no role for band managers.<sup>7</sup>

#### **E. Application, Licencing, and Processing Rules**

***License term and renewal expectancy.*** The Commission proposes a ten year license term, with a renewal expectancy conditioned on a showing of "substantial service."<sup>8</sup> AeroAstro proposes a satellite-based service. Because funding for spacecraft construction and launch commitment typically requires a license in hand, there is unavoidably a long lead time between award of the license and eventual launch. Moreover, in order to keep customers' costs down, AeroAstro squeezes small spacecraft into the marginal excess capacity of large launch vehicles carrying other providers' spacecraft. While inexpensive, this practice requires AeroAstro to wait for a suitable vehicle to become available, then subjects AeroAstro to the large spacecraft's delays.

In view of these considerations, AeroAstro requests a twenty year license term. In the alternative, if the Commission adopts the proposal for a ten year term, AeroAstro requests that the "substantial service" standard for renewal expectancy be modified as discussed below.

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<sup>7</sup> See Notice at paras. 36-40.

<sup>8</sup> Notice at paras. 86-87.

## **F. Operating Rules**

***Performance requirements.*** The Commission's proposed "substantial service" standard for renewal expectancy contemplates a PCS-type build-out, in which relatively inexpensive constructed facilities (such as base stations) each serve identifiable populations.<sup>9</sup> The standard does not readily apply to a service such as AeroAstro's, which becomes available to the entire nation simultaneously after a relatively costly launch. Furthermore, in view of the delays associated with a satellite system (noted above), AeroAstro may not be able to assure service within an initial ten year term.

For these reasons, if the Commission adheres to its proposal for a ten year term, AeroAstro requests that it adopt a renewal standard requiring "substantial progress toward providing service." Benchmarks to be noted in connection with this standard could include commencement of construction, completion of construction, and contract for launch.

The Commission asks whether license cancellation on failure to meet the adopted standard should be automatic or require action by the Commission.<sup>10</sup> As a matter of basic fairness, AeroAstro urges the Commission to distinguish between a near miss, possibly for reasons beyond the licensee's reasonable control, and failure consistent with lack of effort. For this reason cancellation should require Commission action.

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<sup>9</sup> Notice at para. 94.

<sup>10</sup> Notice at para. 95.

## **G. Technical Rules**

***In-band interference control.*** As noted above, AeroAstro supports nationwide licensing. If the Commission instead issues multiple geographical licenses, it must either require frequency coordination or else establish field strength limits at license boundaries.<sup>11</sup> Because AeroAstro proposes a service that potentially entails large numbers of low-power units, we strongly favor the field strength approach. Indeed, a coordination requirement would effectively eliminate AeroAstro's proposed service.

AeroAstro believes an appropriate maximum emission level into a neighboring license area is -35dBW/Hz. Again, however, the adoption of nationwide licensing will moot the need for this standard.

***Out-of-band interference control.*** The Notice seeks comment on out-of-band emissions limits and/or emissions masks, particularly with an eye to protecting the radio astronomy and radiosonde operations at 1660.5-1670 MHz.<sup>12</sup>

Of the three out-of-band standards proposed, AeroAstro believes its proposed emissions limit of -80dBW/Hz offers the best protection to neighboring bands.

**Important:** The rules should specify an absolute out-of-band limit, rather than an emissions mask tied to in-band power. An absolute out-of-band limit will permit a provider that uses low power to specify a less steep emission mask, and hence a less expensive radio, while still achieving the same degree of adjacent-band protection.

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<sup>11</sup> Notice at paras. 98-103.

<sup>12</sup> Notice at paras. 105-112.

**NOTE: AeroAstro is committed to achieving adequate protection of the 1660.5-1670 MHz band. If the users of that band determine our out-of-band proposal of -80 dBW/Hz is inadequate, we will seek to work with those parties to arrive at a mutually acceptable resolution.**

*Power limits and antenna heights.* The Commission asks for recommended limits on transmitter power and antenna height. Limits on output power and EIRP must be consistent with protection of adjacent bands (see above), particularly at 1660.5-1670 MHz, and also with protection of the co-channel meteorological-satellite earth stations at Wallops Island VA, Fairbanks AK, and Greenbelt MD by limiting areas of operation, as discussed below.

With these goals in mind, AeroAstro proposes:

peak output power: 1 watt  
peak EIRP: 10 watts  
antenna height: 6 meters above ground level or building structure.

AeroAstro's own operations are well within these limits. AeroAstro transmitters operate at maximum 1 watt peak output power, and 1 watt peak EIRP. AeroAstro's antenna height is essentially zero. Its transmitters are small, battery-powered devices attached to people, packages, fleet vehicles, soil monitors, and so on. (See Appendix B.) Moreover, AeroAstro's low operating power will make it easy to assure co-channel protection at specified sites by barring operation nearby.

AeroAstro's out-of-band emissions will never exceed -85.5dBW/Hz.

#### **H. Coordination with Government Users**

AeroAstro accepts the need to undertake coordination with NOAA prior to operation within 100 km of GOES earth stations at Wallops Island VA and Fairbanks

AK,<sup>13</sup> and within 65 km of the Greenbelt MD facility during monthly tests and at other times when the facility is active.<sup>14</sup> (If AeroAstro becomes the nationwide licensee at 1670-75 MHz, we intend to consult with NOAA and NTIA about reducing these coordination radii, in view of AeroAstro's low output power. We may also propose a scheme in lieu of coordination whereby AeroAstro's transmitters automatically cease operating within the coordination circles. If those discussions fail, however, we will accept the coordination parameters above.)

### **CONCLUSION**

AeroAstro urges the Commission to adopt flexible regulations for the 1670-75 MHz band, consistent with interference concerns.

Because all of the parties offering specific proposals for the band intend to provide nationwide service, the Commission can maximize the value of spectrum by adopting nationwide licensing. Licence terms and performance requirements should be compatible with a satellite-based system that does not entail a build-out of local facilities.

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<sup>13</sup> See 47 C.F.R. Sec. 1.924(f).

<sup>14</sup> Notice at para. 131.

AeroAstro proposes specific technical rules that are more generous than its own system requires, but which should afford adequate protection to adjacent users, especially at 1660.5-1670 MHz, and to co-channel Government users at specified sites. AeroAstro is fully committed to protecting adjacent-band radio astronomy and radiosonde operations, and if necessary will work with those parties to arrive at acceptable limits.

Respectfully submitted,

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March 4, 2002

## **Appendix A -- About SENS**

AeroAstro's Satellite Enabled Notification System (SENS), now under active development, enables users to transmit short data messages from any location on the globe, for receipt via the Internet in near-real-time. The system has three key components: (a) small, low-cost mobile ground terminals, (b) small, low-cost space stations, and (c) fixed ground receiver stations. The mobile terminals transmit low-power, spread-spectrum modulated messages to the satellites, which act as bent pipes to relay the data down to the nearest ground receiver station.

SENS will use the 1670-1675 MHz band only for uplinks from mobile terminals to satellites. No downlinks will be operated in the band.

SENS can also be operated in a terrestrial mode, for applications that are confined to an area of a few kilometers. Instead of a satellite, this implementation uses a tower-mounted receiver with line-of-sight to the active terminals. One early application of this type will use SENS terminals to monitor aircraft noise at locations around an airport, under an experimental license. Similar terminals can be used for both terrestrial and satellite applications, if the same frequency band is available for both.

SENS mobile terminals are direct sequence spread spectrum transmitters, operating at one watt or less, in full compliance with Section 15.247 (except for choice of band). These have the lowest cost, complexity, size, and weight, and require the least supporting infrastructure, of any space-based communications system to date. In commercial quantities, the terminals will cost only a few dollars each to manufacture. A global quasi-real-time service will need only two small launches of clusters of very low cost microsatellites. Thus, both the user's terminal and access costs will be very low.

Small size and minimal cost will enable SENS to provide critical services not presently available. Using inexpensive GPS technology, SENS can report basic position as well as status data on millions of deployed, highly miniaturized, autonomous terminals. These will eventually be small enough to build into a wristwatch, a bracelet, or a shoe. Early users of SENS terminals will include hikers, hunters, surveyors, and others whose occupation or pastime puts them at risk in the outdoors. Anywhere in the United States, and eventually the world, the push of a button will provide an alert and position fix. In some applications, units will transmit automatically at fixed time intervals or in response to specified external events. SENS terminals may ultimately become a standard feature in children's shoes, military ID bracelets, and even clothing of people who travel or recreate in wilderness areas. Their families and associates can receive frequent updates via the Internet on the traveler's status and position, with histories over time.

SENS can be used to enhance personal safety and security. Older and infirm persons can use SENS to call for assistance. Children can have SENS terminals clipped to their clothing at amusement parks and similar sites where there is a risk of becoming

separated from caregivers. Motorists stranded in isolated areas can summon help. Anyone can use SENS as a personal security device, possibly dangling from a key chain.

The tiny, low-cost, low-power SENS uplink terminal can be attached to packages, utility poles, cattle, fleet vehicles, railroad cars, and other deployed capital assets to monitor their positions and conditions. Trucking companies can gather data on speed, mileage, even engine temperature. Soft-drink and other vending machines can report low-stock conditions. The terminals are so low in cost and small in size that they can be distributed over an agricultural area to monitor water, fertilizer, and pesticide concentrations, along a border crossing to monitor immigration, at building doors and windows to report intruders, or on smoke, heat, and flood alarms for remote monitoring.

In short, SENS combines personal security, asset and resource management, communications, and remote sensing applications in a communications network. It will be a pathfinder for new services, a first point of entry for many clients into wireless and satellite-based services, and a catalyst for other similar systems. Once the system is in place, users no doubt will identify dozens of other applications.

***Technical information.*** Using direct sequence spread spectrum, very low power, and a very high gain satellite-based receiving antenna, SENS emissions are highly spectrum efficient and non-interfering. Except for choice of band, SENS transmitters comply with the Commission's technical requirements for spread spectrum devices. *See* 47 C.F.R. Sec. 15.247. Like other spread spectrum applications, SENS signals can share spectrum with narrowband or other spread spectrum signals with little risk of harmful interference. Terminal data message length is restricted to approximately 128 bits. Data rate will be 100 bits/second, for a transmission time per message of about 1.28 seconds. Terminals can be programmed to transmit 2-3 messages in a 24 hour period, as well as to transmit on command from an attached sensor (to report a button press or an alarm condition). Output RF power from a terminal will be approximately -33 dBm/Hz. Low power output makes the terminals safe in any application.

## **Appendix B --About AeroAstro**

Since its founding in 1988, AeroAstro has focused exclusively on lowering the cost of working in space so as to make space activities accessible to a broader community. The company has brought space to students at high school through post-graduate level, scientists operating on very limited research budgets, small start-up businesses, and the general public. In doing so, AeroAstro has pioneered new uses of space and spacecraft that are appropriate to our low cost, highly accessible approaches to aerospace engineering. Our revenues have doubled each of the last four years, and our staff has increased fourfold over the same period.

AeroAstro's first satellite, ALEXIS, is a small spacecraft developed for the Los Alamos National Laboratory to provide high resolution maps of low-energy x-ray sources and ionospheric physics. AeroAstro designed and built the spacecraft bus and the ground station, and also supported the launch and ground operations activities. ALEXIS was launched in April 1993 and is still operational over six years later, far exceeding its design lifetime of six months.

HETE (High Energy Transient Experiment) is a small satellite developed at AeroAstro for the Massachusetts Institute of Technology. Its mission is detection and observation of high energy events in the gamma ray, X-ray, and UV spectra. AeroAstro provided the spacecraft bus, ground stations, and all payload integration and tests. HETE was launched but lost due to a Pegasus XL failure on November 4, 1996.

TERRIERS (Tomographic Experiment using Radiative Recombinative Ionospheric Extreme Ultraviolet and Radio Sources) is AeroAstro's most recently completed satellite, developed at AeroAstro for Boston University. Its mission is to demonstrate global ionospheric tomography and to utilize this technique for the study of ionospheric/ thermospheric processes. AeroAstro provided the spacecraft bus, ground stations, and all payload integration and tests. TERRIERS launched successfully in May 1999.

AeroAstro built the S-band spacecraft radios and S-band tracking ground stations for each of the three spacecraft described above, and developed internally all of the software for both the spacecraft and ground stations. In addition, AeroAstro built a set of S-band radios for the Swedish FREJA spacecraft, which functioned in orbit for the full 1 year lifetime of that satellite. Recently, AeroAstro also built a set of S-band transmitters for use on the Canadian MOST microspacecraft, slated for launch this year.

In 1997, AeroAstro completed the system architecture and design for a LEO spacecraft-based messaging system for an Australia-based firm, KITComm. This system shares some design features with the proposed SENS system, although it is substantially more complex.

Through the NASA Small Business Innovation Research (SBIR) program, AeroAstro is developing compact, power-efficient, inexpensive X-band radios for nanosatellites. The initial design phase has been completed and prototyping is beginning, with an ultimate objective of developing a product suitable for commercialization. These X-band transponders were also recently selected to provide Earth/Space communications for the NASA New Millennium Program's ST5 mission. This mission, the Nanosatellite Constellation Trailblazer, will provide validation of innovative, new technologies for future space missions.

AeroAstro is currently under contract to build two additional small spacecraft. The first, STPSat-1, is the most sophisticated to date, a 190 kg spacecraft bus being fabricated for the Air Force's Space Test Program for launch in 2005. The second, SPORT (for Small Payload Orbital Transfer vehicle) is being built for a foreign government for launch in 2004. AeroAstro is developing a new miniaturized S-band transponder for the SPORT (and other future) spacecraft.

AeroAstro has performed dozens of system designs and studies for organizations including Jet Propulsion Laboratory, Los Alamos National Laboratory, Naval Research Laboratory, NEC, Canadian Space Agency, NASA, Nissan, Philips Labs, and numerous U.S. universities. The company has also developed numerous spacecraft system components for these clients, including sun sensors, NiCad and Li-Ion batteries, mass memories, processor boards, power controllers, cold gas thrusters, electromagnetic torquers, and attitude control software.

### **SERVICE LIST**

I certify that I have caused copies of the foregoing "Comments of AeroAstro, Inc." to be transmitted by email and by hand delivery to the following persons:

Chairman Michael Powell  
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Commissioner Kevin J. Martin  
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